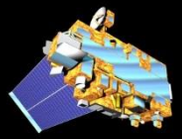
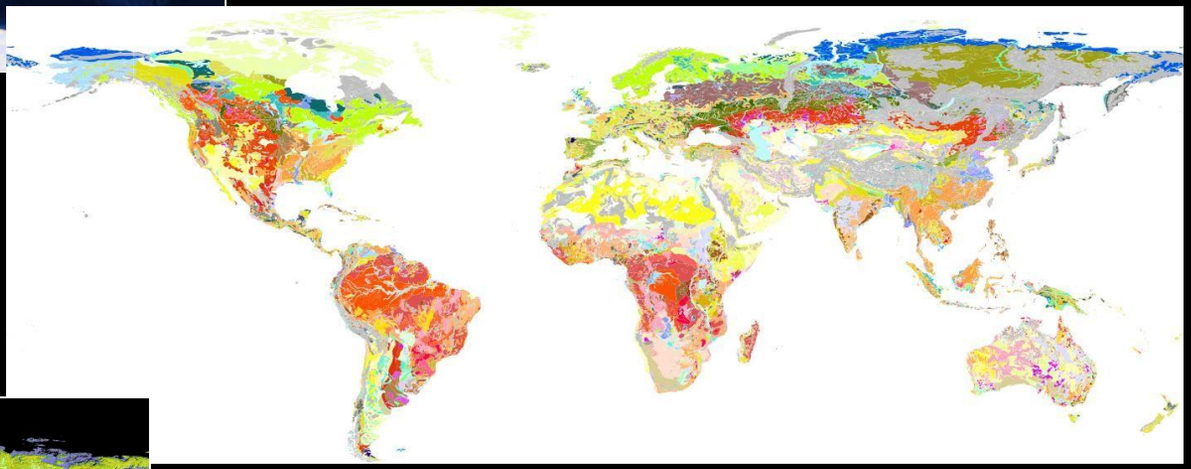


Satellite ASTER Global Geoscience Maps

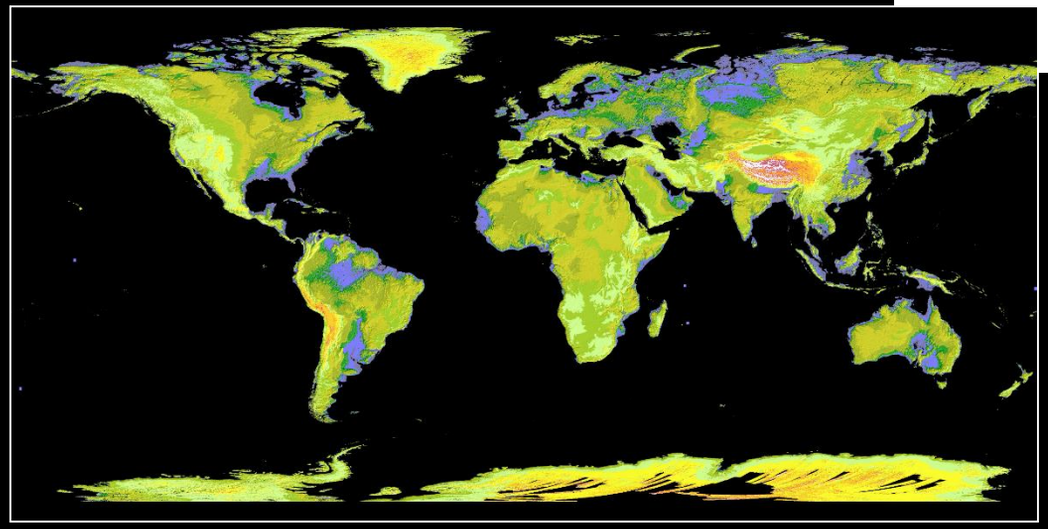
Michael Abrams
Jet Propulsion Laboratory, California Institute of Technology, Pasadena USA

Global Maps

Global Geology

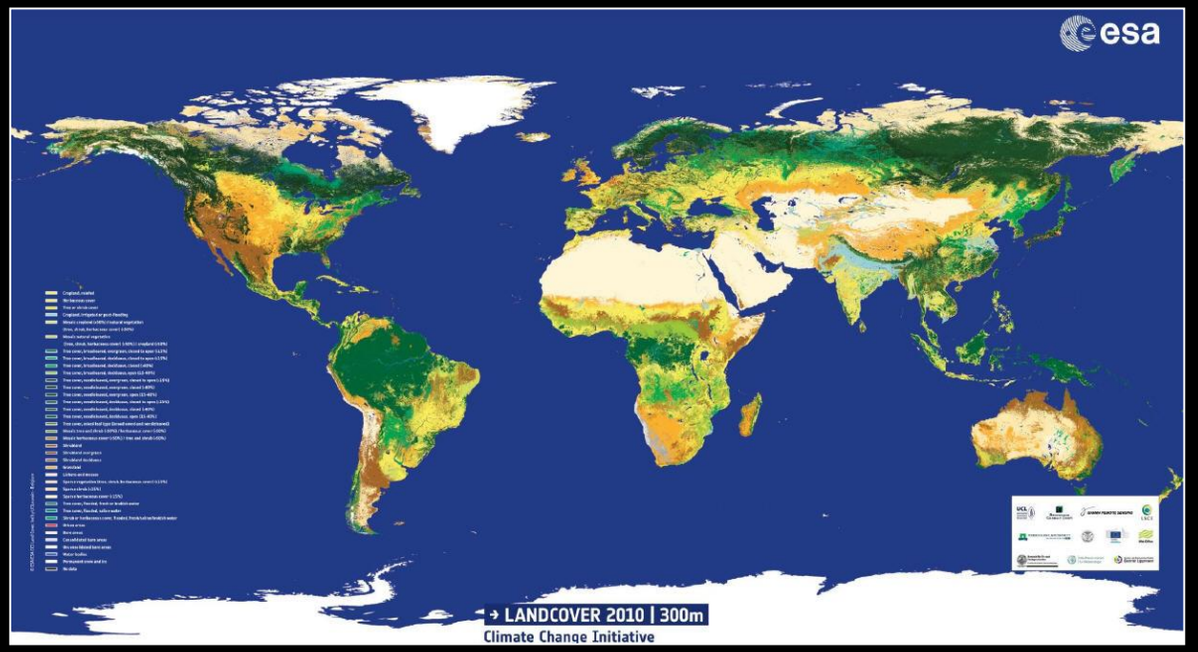


Global Soils



Global DEM

Global Maps



Land use/Land cover

GLOBAL SURFACE COMPOSITION MAP

???

GROUP ON EARTH OBSERVATIONS

GEO Community Activity "Earth Observations for Managing Mineral and Non-renewable Energy Resources" (CA-06)

Global mineral map of the Earth's surface

- Australia Geoscience mineral map
- Global spectral libraries of soils in view of future IS spaceborne missions

Global GEO community portals

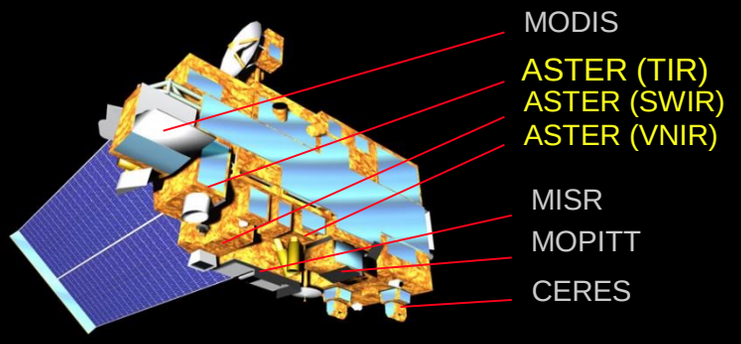
EO-based integrated products for monitoring environmental and societal impacts:

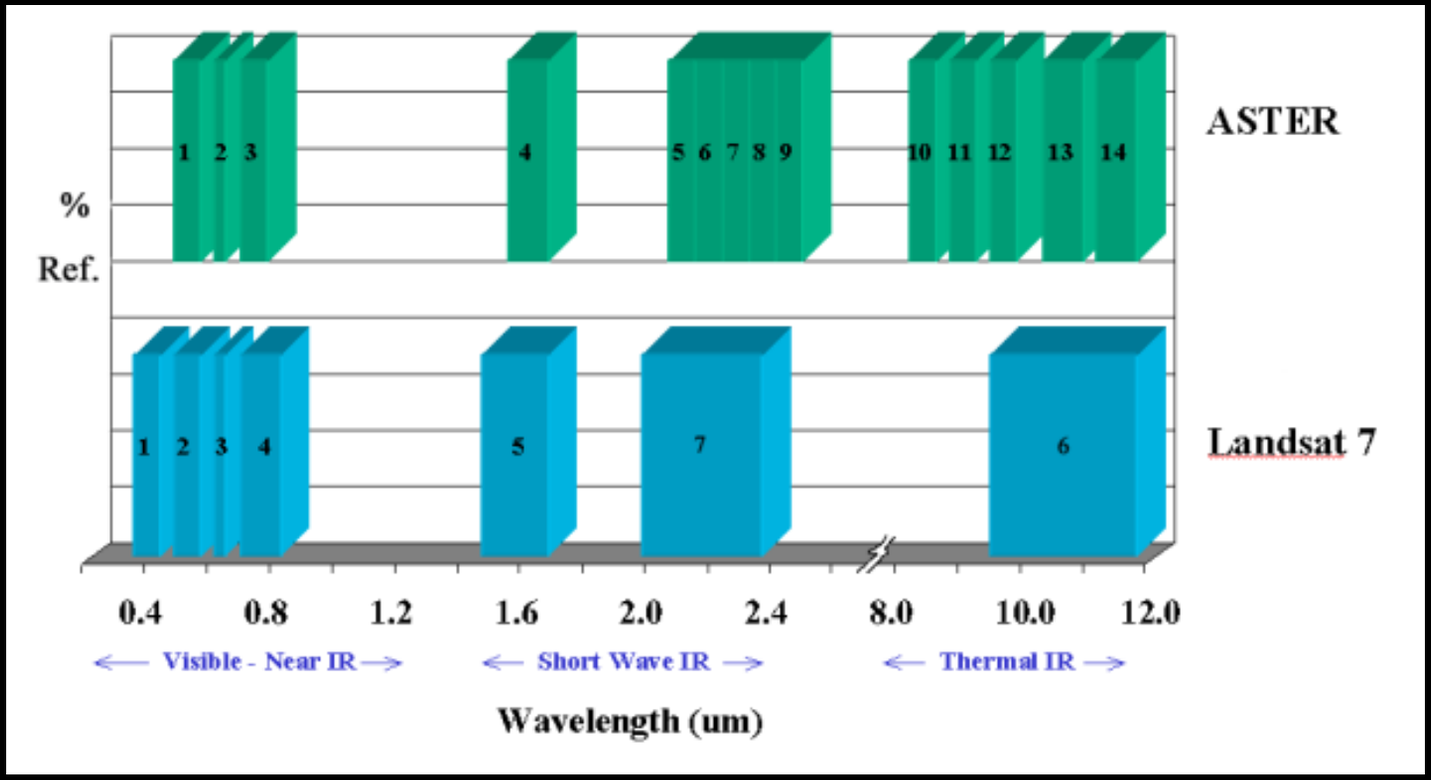
- National to regional (e.g. illegal mining, GFOI, GMOS)
- Local : mine site, SLO...

What is ASTER?

ASTER Instrument

- 1999 launch on Terra
- Joint Japan/US effort
- 15 m vnir, 30 m swir, 90 m tir
- 60 km swath
- < 16 day repeat cycle





> 3 million scenes in archive

Australia ASTER Geoscience Maps Released in 2014

False Color IR
Landsat TM regolith ratios
Green vegetation
Ferric oxide content
Ferric oxide composition
Ferrous iron index
Opaque index
AlOH group content
AlOH group composition
Kaolin group index

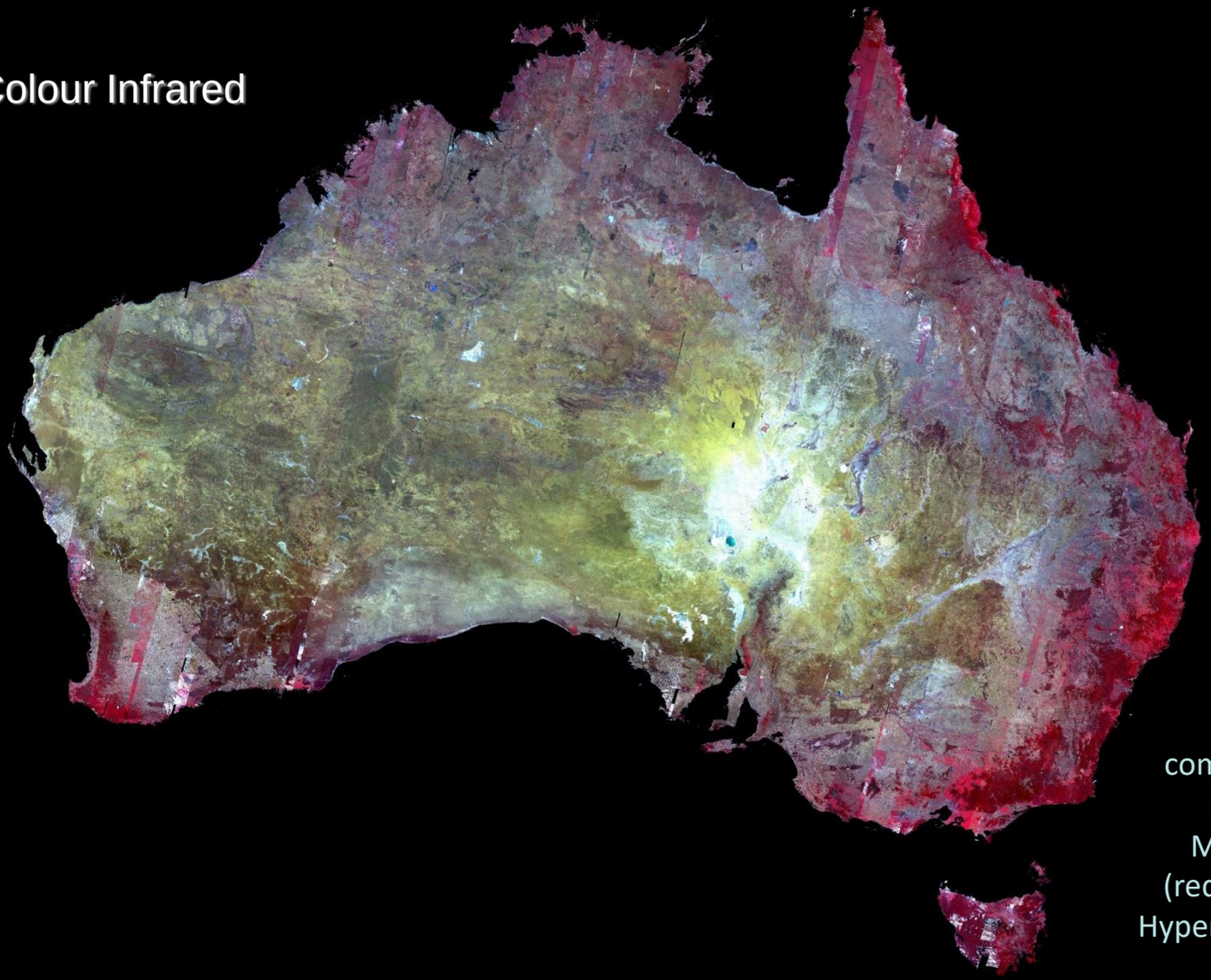
FeOH group content
MgOH group content
MgOH group composition
Ferrous iron in MgOH/Carbonate
Silica index
Quartz index
Gypsum index

VNIR
VNIR + SWIR
SWIR
TIR

Algorithms used to produce Australia ASTER Geoscience Maps

Product name (in red)	Base algorithm B=band No. = band No.	Masks	Stretch^ (lower limit)	Stretch^ (upper limit)	Stretch+ type
9. AlOH group composition	B_5/B_7	Composite mask* + green vegetation <1.75 + AlOH content $(B_5+B_7)/B_6>2.0$	0.9 Blue is well ordered kaolinite, Al-rich white mica (muscovite, illite, paragonite), pyrophyllite, beidellite	1.3 Red is Al-poor (Si-rich) white mica (phengite), montmorillonite	gaussian
	Accuracy: Moderate: Mixing with minerals like chlorite and carbonate and dry/green vegetation will make colours appear warmer than the actual Al-OH composition while cool colours (blue and cyan) can be compromised by mixtures with alunite and dry plant material. *Note 1*: Use in combination with the Al-OH group content to discount the geological importance of those pixels with low contents. That is, discount the value of any isolated warm-coloured pixels, such as those associated with fire scars.				
	Geoscience Applications#: From Figure 5, useful for mapping: (1) exposed saprolite/saprock is often white mica or Al-smectite (warmer colours) whereas transported materials are often kaolin-rich (cooler colours); (2) clays developed over carbonates, especially Al-smectite (montmorillonite, beidellite) will produce middle to warmers colours. (2) stratigraphic mapping based on different clay-types; and (3) lithology-overprinting hydrothermal alteration, e.g. Si-rich and K-rich phengitic mica (warmer colours). Combine with Ferrous iron in MgOH and FeOH content products to look for evidence of overlapping/juxtaposed potassic metasomatism in ferromagnesian parent rocks (e.g. Archaean greenstone associated Au mineralisation) +/- associated distal propyllitic alteration (e.g. chlorite, amphibole).				
10. Kaolin group index (pyrophyllite, alunite, well-ordered kaolinite)	B_6/B_5	Composite mask* + Green vegetation <1.4	1.0 Blue is low content	1.125 Red is high content	linear
	Accuracy: Moderate: Complicated by dry plant material, fire scars, thin cloud and AlOH poor areas dominated by "mafic" minerals.				
	Geoscience Applications#: Useful for mapping: (1) different clay-type stratigraphic horizons; (2) lithology-overprinting hydrothermal alteration, e.g. high sulphidation, "advanced argillic" alteration comprising pyrophyllite, alunite, kaolinite/dickite; and (3) well-ordered kaolinite (warmer colours) versus poorly-ordered kaolinite (cooler colours) which can be used for mapping *in situ* versus transported materials, respectively.				
11. FeOH group content (chlorite, epidote, jarosite, nontronite, gibbsite, gypsum, opal-chalcedony)	$(B_6+B_8)/B_7$	Composite mask* + Green vegetation <1.4	2.03 Blue is low content	2.25 Red is high content	linear
	Accuracy: Low: Complicated by cloud, especially thin cloud, as well as green and dry vegetation, carbonate (magnesite and to a lesser degree dolomite). Use in combination with the MgOH and vegetation products (including regolith ratios) to help unravel complicating vegetation effects.				
	Geoscience Applications#: Useful for mapping: (1) jarosite (acid conditions) – in combination with ferric oxide content (high); (2) gypsum/gibbsite – in combination with ferric oxide content (low); (3) magnesite - in combination with ferric oxide content (low) and MgOH content (moderate-high) (4) chlorite (e.g. propyllitic alteration) – in combination with Ferrous in MgOH (high); and (5) epidote (calc-silicate alteration) – in combination with Ferrous in MgOH (low).				

False Colour Infrared

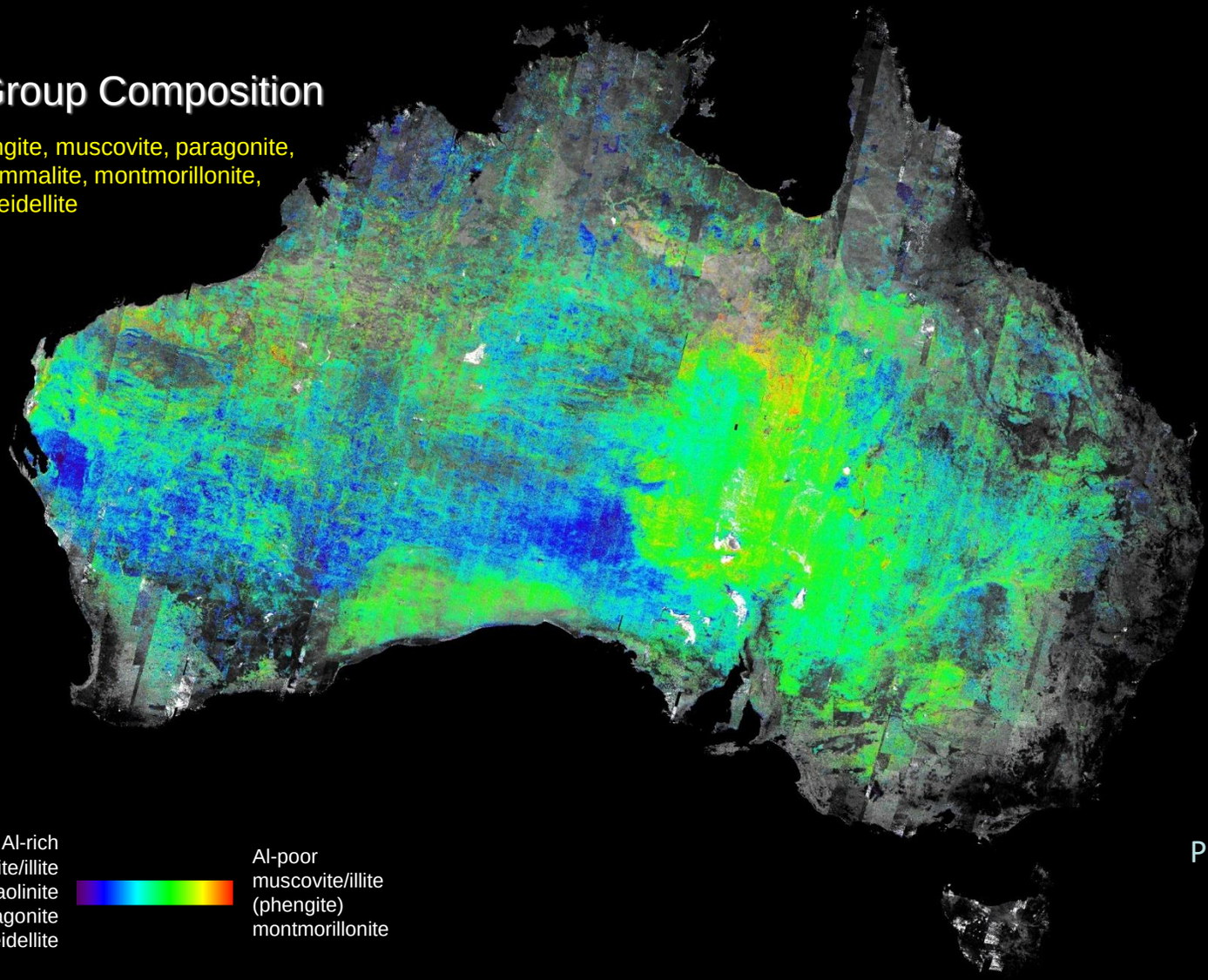


Australian ASTER mosaic comprises 3500 ASTER scenes spanning a 10 year period. Mosaic was cross-calibrated (reduced to reflectance) using Hyperion satellite hyperspectral imagery.

Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

AlOH Group Composition

e.g. Al-Clays: phengite, muscovite, paragonite, lepidolite, illite, brammalite, montmorillonite, kaolinite, dickite, beidellite



Al-rich
muscovite/illite
kaolinite
paragonite
beidellite

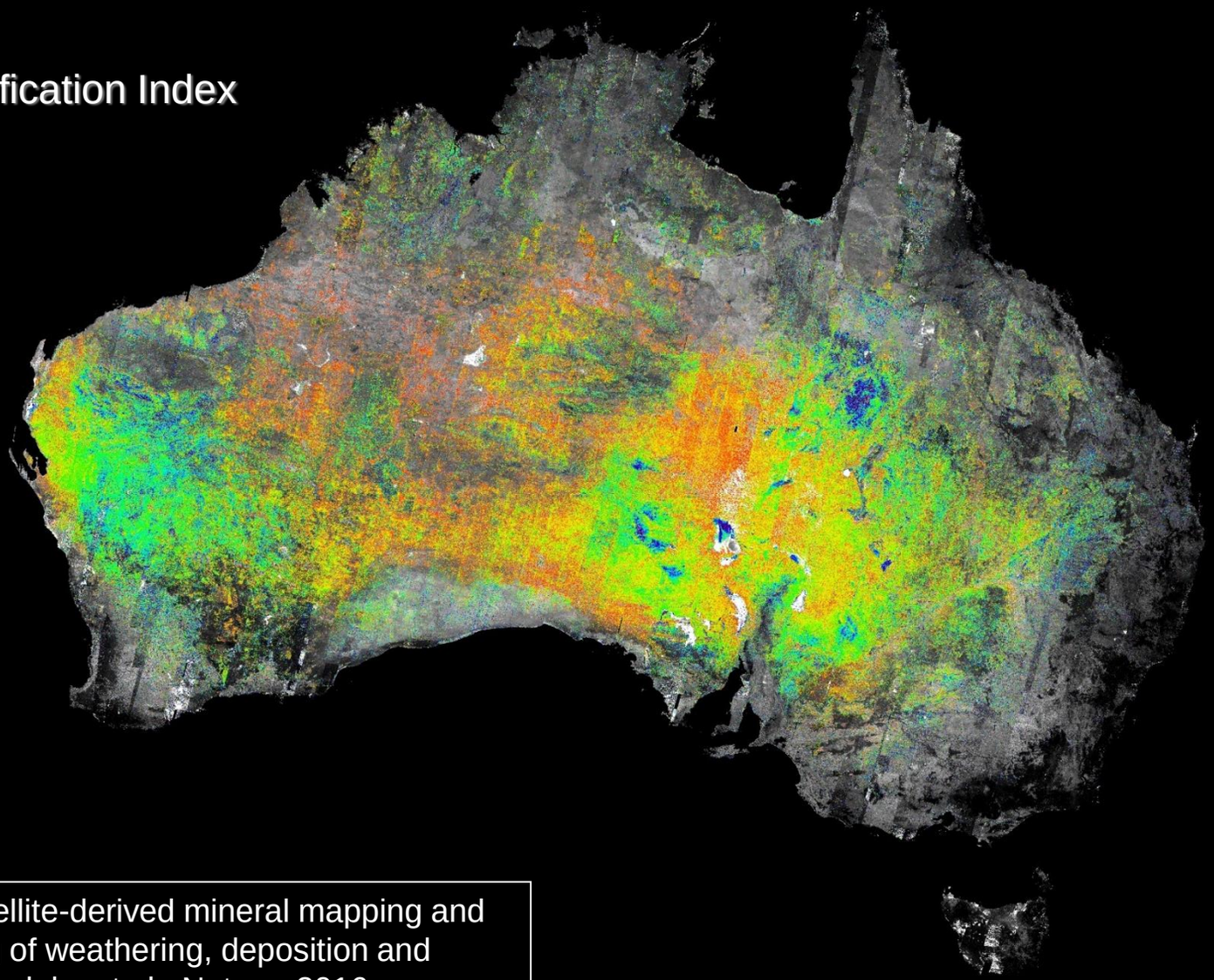
Al-poor
muscovite/illite
(phengite)
montmorillonite

White mica chemical gradients (exploration)
Transported versus *in situ* regolith materials.
Productive agricultural soils.
Surface permeability (water catchments).
pH indicator.

Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

2017 IGARSS July, 2017

Desertification Index



loss through wind erosion

From: Satellite-derived mineral mapping and monitoring of weathering, deposition and erosion, Cudahy et al., Nature, 2016.

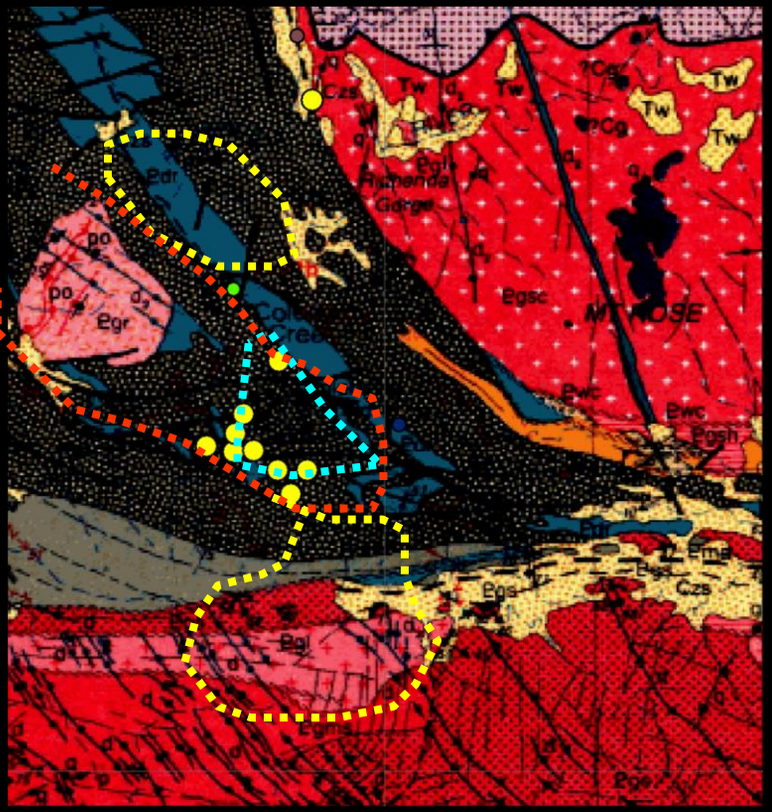
Non-renewable resource exploration

Halls Creek Mobile Zone, WA

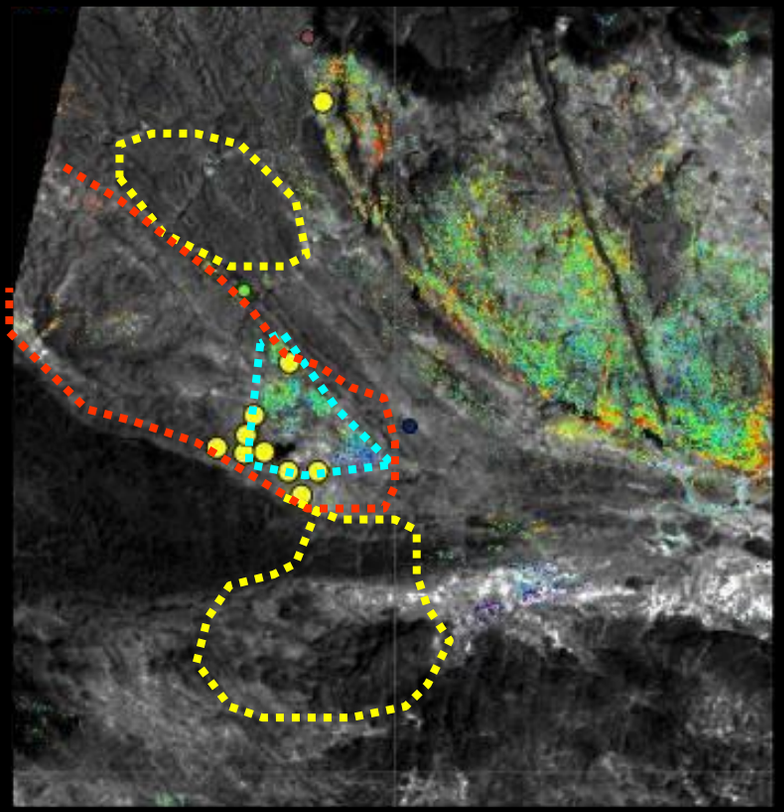
Distal Footprints

phyllic zone
argillic zone
oxidised zone

published 250K geology

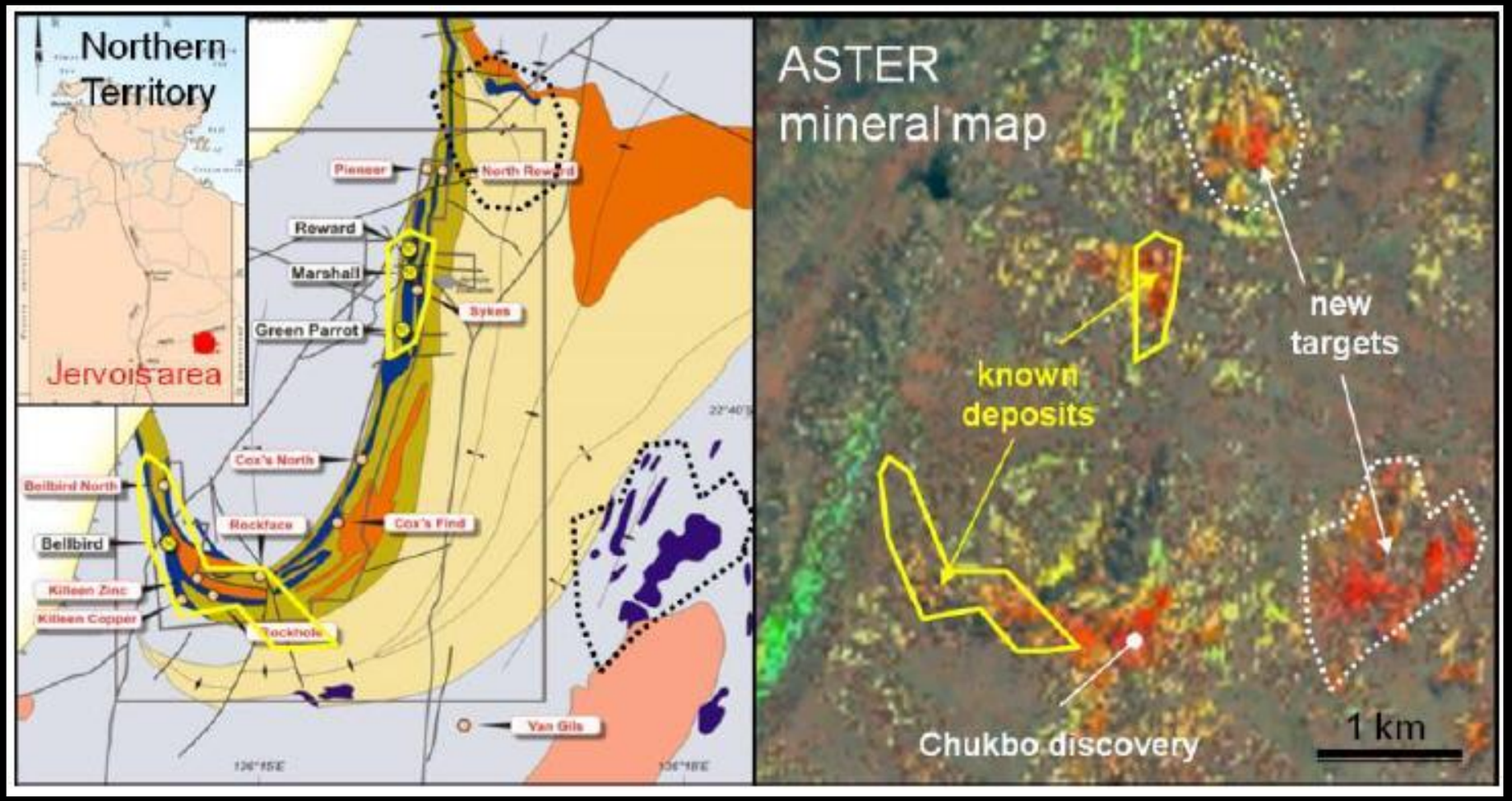


ASTER AlOH Group composition



First Announced Gold Discovery Using ASTER Australia Geoscience Maps

Kentor Gold Ltd. announced in 2014 the Chukbo deposit in Northern Territory, Australia, based on coincident phyllic and propyllitic alteration. Several new targets were also identified



From ASTER Geoscience Maps of Australia

To

ASTER Global Geoscience Maps

Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

Data Processing at JPL

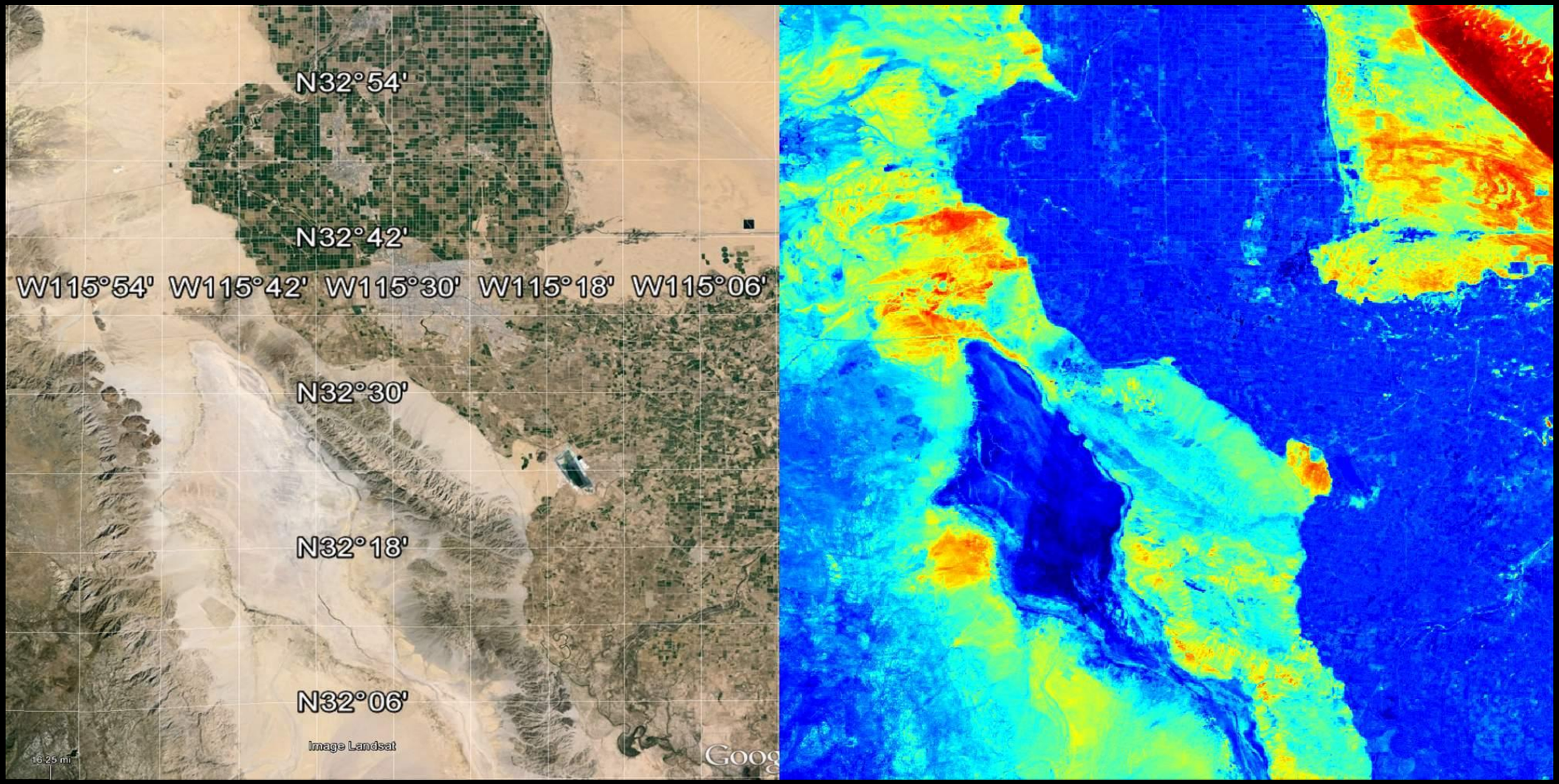
- Hulley (JPL) created Global Emissivity Database from all ASTER data acquired 2000-2008. Data were pre-processed to create: cloud mask and vegetation mask. All 14 ASTER bands, for 1.3 million scenes, are stored locally, with associated masks. The data are resampled to 100m for all bands.

- Australian-developed Geoscience algorithms will be applied to this data set. Processing will be done on work stations or JPL cloud computing facility.

- First continent to be completed will be Australia. The continental product will be compared to Australian Geoscience maps, and adjustments made to leverage off of CSIRO's validation with Hyperion data and thousands of field chemical/mineralogical measurements. The other continents will follow, and be released as completed.

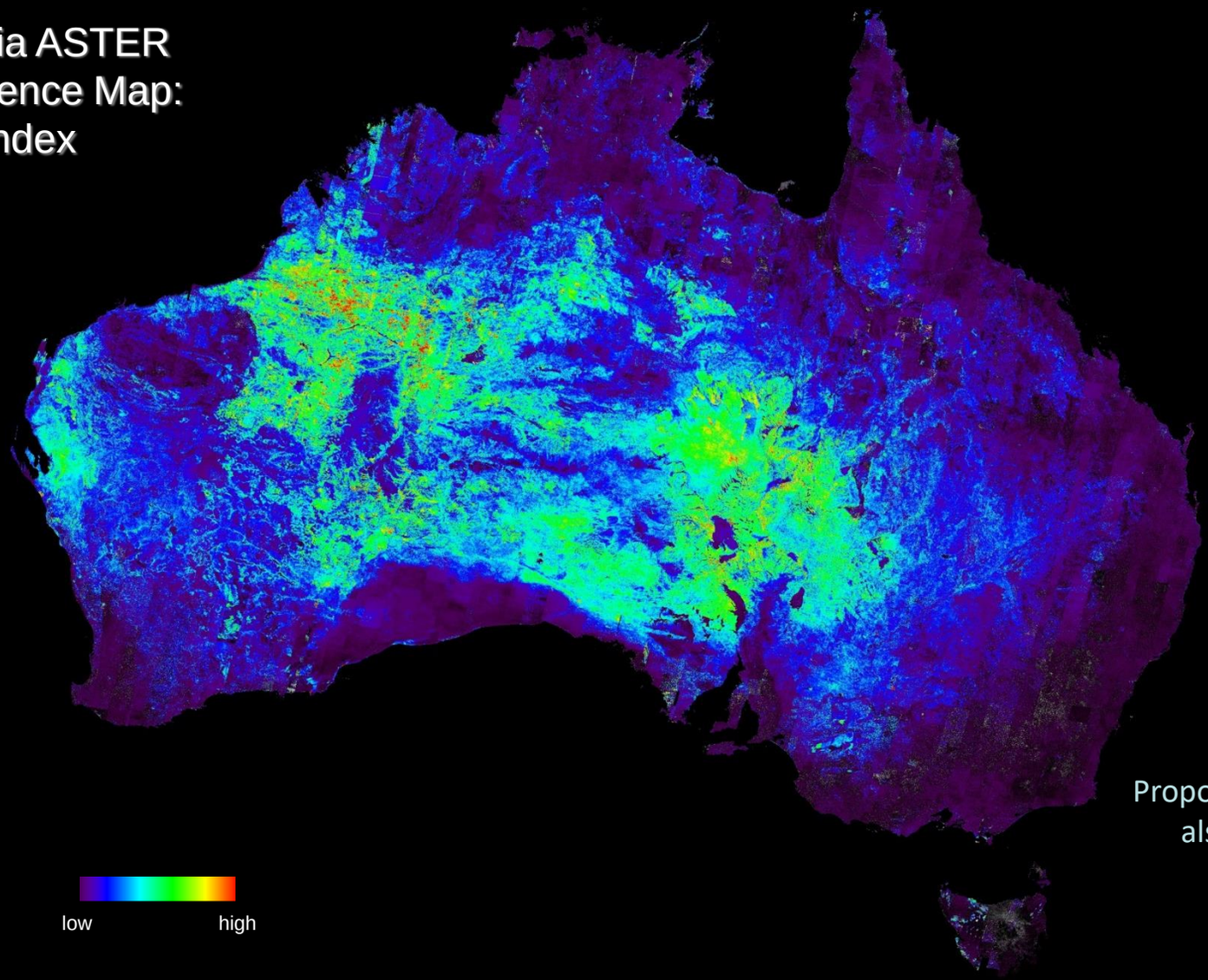
Sample ASTER Global Geoscience Product

Silica index for 1 x 1 degree tile in Southern California
Created from TIR band ratios
red = high, blue = low



Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

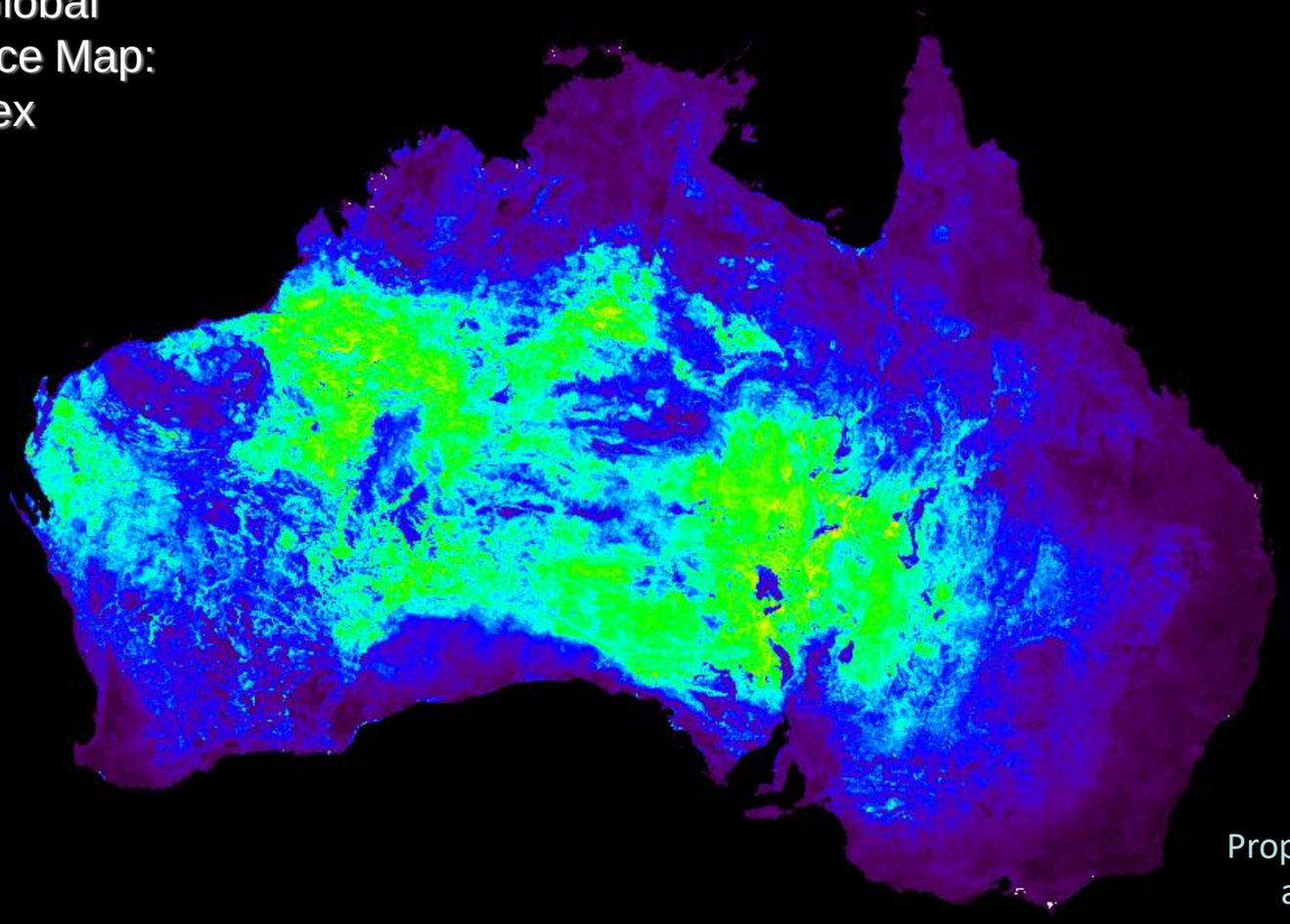
Australia ASTER Geoscience Map: Silica Index



Proportional to SiO_2 content but also effected by particle size. Regolith mapping.

Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

ASTER Global Geoscience Map: Silica Index



Proportional to SiO_2 content but also effected by particle size. Regolith mapping.

Michael Abrams, Jet Propulsion Laboratory/California Institute of Technology

NASA MEaSUREs RFP

- Requested proposals to create (or extend) Earth System Data Records, for example, Sea Surface Temperature
- ***May 2017, Abrams submitted proposal to NASA to produce ASTER Global Geoscience Products***
- Funding decision expected ~September, project start December 1
- Geoscience Maps produced continent-by-continent
- All maps will be available through NASA Land Processes DAAC starting end 2018